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ABSTRACT

The purpose of this "primer" for the general public is to describe the general characteristics of wetlands and how wetland alteration adversely affects the well-being of humans. Particular emphasis is placed on wetlands in New York State and the northeast. Topics discussed include wetland values, destruction of wetlands, the costs of wetland destruction, and laws related to wetlands. A section titled "glossary" contains detailed information on the physical characteristics of freshwater wetlands. It includes discussion about the water cycle, general definition for wetland, wetland classifications, wetland geology, and characteristics. (Contains 6 references.) (MCO)

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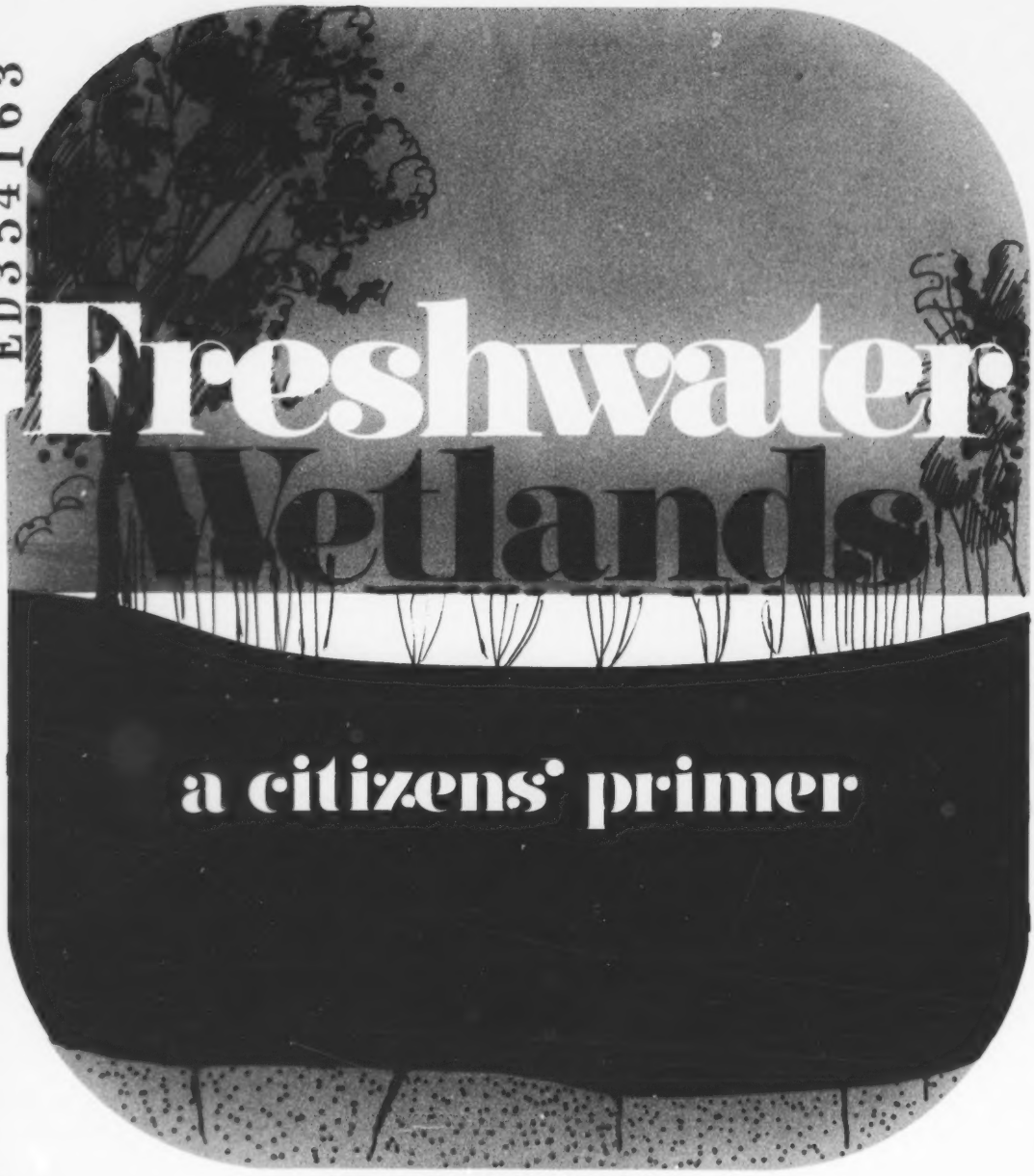

Freshwater Wetlands

a citizens' primer

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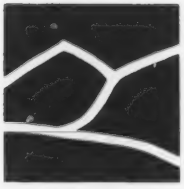
Freshwater Wetlands

a citizens' primer



June, 1978
The Catskill Center For Conservation And Development, Inc.
Hobart, New York

Prepared by Thomas H. Miner
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preface

"FRESHWATER WETLANDS: A Citizens' Primer" is the first in a series of publications by The Catskill Center which will focus on environmental, cultural and human resources within the Catskill region.

The purpose of this report is to describe the general characteristics of wetlands and how their alteration adversely affects man's well-being. The subject has special significance because of the New York State Freshwater Wetlands Act of 1975 which took effect September, 1975. Throughout, the term "wetlands" will refer to freshwater wetlands. Saltwater or coastal wetlands, although of equal value, are not discussed in this booklet.

The Catskill Center gratefully acknowledges the assistance and material provided by the Massachusetts Audubon Society Wetland Project and the Water Resources Research Center of the University of Massachusetts at Amherst. Specific credit for the illustrations used herein is given to the Wetlands Project, in whose publication "Wetlands and the Watercycle" most of them first appeared. The Center also wishes to thank the Dutchess County Environmental Management Council and the New York State Department of Environmental Conservation for their review and encouragement of this publication.

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Introduction

THE STORY OF WETLANDS in New York State and the Northeast is the story of an endangered natural resource. Although early settlers and native Indians realized the productivity of wetlands for game and plant materials essential to their daily survival, most people have come to regard wetlands as worthless in their natural state. Prior to the birth of our present environmental awareness, only a few individuals with specific interests in wetland ecology voiced a growing concern for their protection. With silent approval the vast majority allowed wetlands to be diverted to other use. Filled, wetlands provided town dumps, subdivisions and industrial sites; drained, they produced pasture and crop land.

Nationwide the result has been the elimination of approximately 45 million acres of wetlands, more than a third of the total resource, and the severe modification of more than half the remaining total. In New York State alone, more than half of an estimated 1.3 million original wetland acres have been lost through man's activities since colonial times.

The serious consequences of this loss are now apparent as knowledge about the functions of wetlands continues to grow. With the passage of the New York State Freshwater Wetlands Act of 1975, New York joined Connecticut, Rhode Island, Massachusetts, New Hampshire, Maine, Wisconsin, and other states in formally recognizing the importance of maintaining wetlands in their natural state by establishing a mechanism for their protection. To better understand the need for such laws it is necessary to understand the functions of wetlands, the ways in which they are destroyed, and the impact of their destruction on local communities.

Wetland Values

WETLANDS IN THEIR NATURAL STATE perform many services to surrounding areas. Their roles may vary among the different classes and locations (see Glossary) but, in general, wetlands provide flood and storm protection; convert pollution to useful nutrients; store water; accommodate sedimentations; foster ground water recharge; and nurture wildlife, waterfowl and fish.

Flood Control

When a rain storm occurs, excess water that cannot be absorbed runs off across the earth's surface, flowing downhill into larger and larger streams. If the rainfall is heavy or lasts a long time, these streams will overrun their banks and flood adjacent areas. The presence of wetlands allows this flood to spread out and slow down, lowering flood crests and ebbing the destructive force of the water.

Large amounts of water added over a short period of time do not harm wetlands. A single acre of wetland, flooded to one foot, can hold 325,850 gallons of water. With this large receptive capacity, wetlands act as giant sponges, absorbing excess water and then releasing it slowly once the source has returned to a normal flow. This extended release can represent a supply essential to continued streamflow in a dry season.

Wildlife Habitat

All wildlife has a basic need for food, cover and water. Wetlands provide all three, with many species depending on them for survival. Numerous waterfowl and furbearers such as muskrat, mink, beaver and otter are directly associated with wetlands. Marsh birds, songbirds, deer, rabbits, pheasant and grouse utilize them as well. For migrating wildfowl, wetlands in New York and the Northeast are essential feeding areas during the spring and fall migrations. Many local wetlands also serve as breeding areas for wood ducks, black ducks, mallards and blue-winged teal. And, as noted in the Freshwater Wetlands Act, wetlands are the preferred habitats for such rare and endangered species as the bald eagle and osprey.

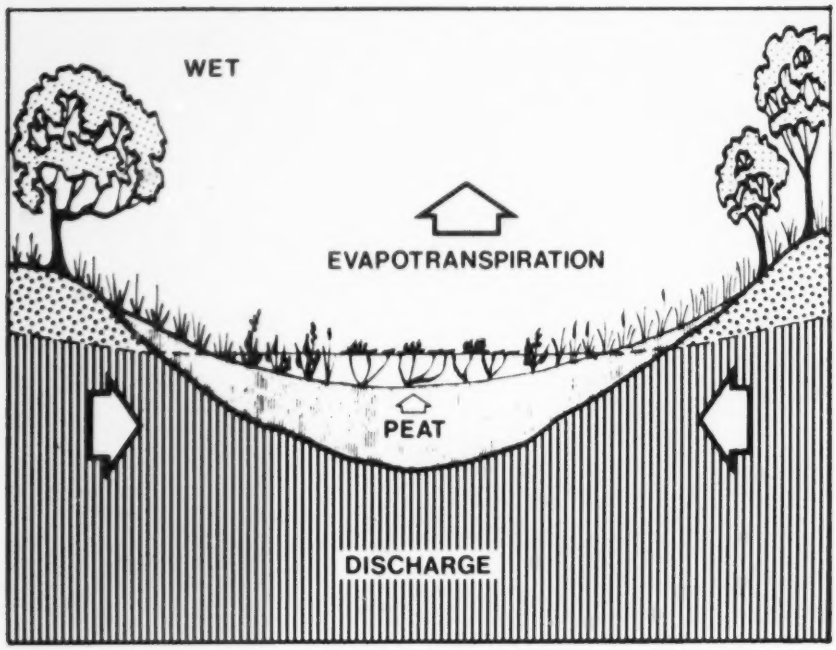
Wetlands also attract a variety of species by their natural variety of plants, shrubs and trees; and by their intermix of land and water areas. Such species diversity is important to the stability of local biological communities. In addition, by providing natural separation within habitats and abundant food sources, wetlands can host large numbers within each species.

Water Resources

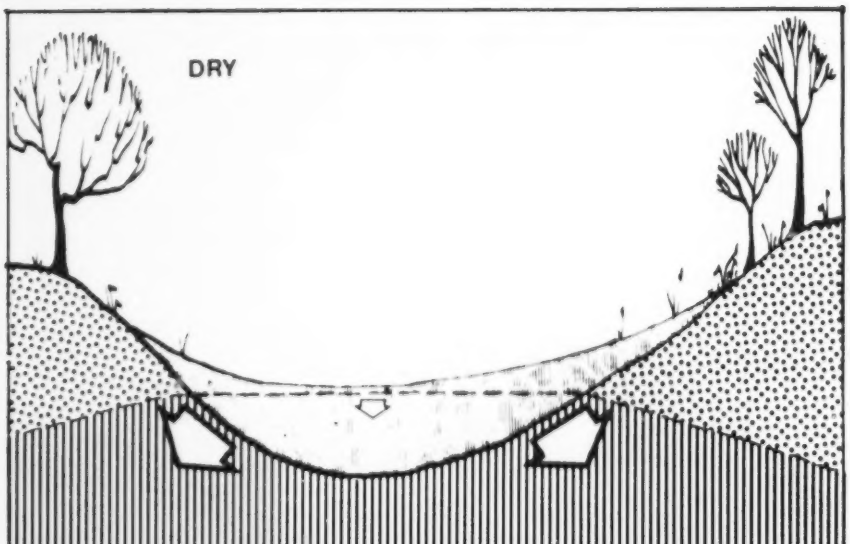
There is a direct relationship between wetlands and groundwater (see Glossary "Wetland Geology"). The specific role of wetlands in the groundwater system varies from season to season. During most of the year ground water flows into wetlands and they (Figure 1 — Discharge/Recharge) act as small watersheds, collecting, storing and discharging water. In dry seasons or during an extended drought, wetlands may recharge the groundwater system. During these times, standing water in a wetland may be an important contribution to aquifers depended upon for potable water supplies.

Some wetlands are directly related to, or indicative of aquifers with public water supply capability. As public demand for water exceeds presently available sources a wetland aquifer's potential for potable water supply becomes increasingly important. The number of wetlands underlain by productive ground water could be large. Studies in Massachusetts indicate that the number of such wetlands may be as high as 40-50% of that state's total. However, this supply should not be taken for granted. Its development requires detailed geologic and hydrologic studies to ensure adequate indentification and evaluation. Further, the "safe yield" of such a source would

FIGURE 1



Groundwater movement in discharge season



Groundwater movement in recharge season

have to be determined to prevent harm to either the wetland or the aquifer beneath.

Recreation and Open Space

The traditional image of a wetland as a dismal, mosquito-infested swamp hardly seems compatible with the idea of recreation. The physical make-up of wetlands, with their differing vegetative types and mix of dry land with water bodies, can produce recreational areas of unique variety and scenic beauty. The fact that activities associated with wetlands require little or no organization, in-place equipment or development is of particular benefit to the community. And, with the exception of trails and boating facilities, there is little maintenance required.

Those interested in wildlife have long known of their value for many activities, including hunting and fishing. (Many of these individuals were, in fact, some of the first to call for wetland protection). Recreational opportunities are as varied as the persons looking for them. Aside from hunting and fishing, different wetlands provide varying opportunities for bird watching, nature photography, hiking, bicycling, horseback riding, backpack camping, canoeing, trapping, cross-crountry skiing, skating and picnicking.

Wetlands also represent valuable open space, especially in urbanizing areas. Due to the expense of traditional development (e.g. draining or filling), they are often the only undeveloped areas left in many communities. Their open space value is enhanced by their generally "wild" or "natural" character when left unaltered. They are also areas of intense visual enjoyment through their natural variety of heights, slopes and surfaces.

Pollution Control

Wetlands can play a significant role in improving water quality. Up to a point they act as natural purifiers. Much in the way that expensive sewage treatment plants remove pollutants from wastewater, wetlands filter and biologically cleanse water that flows into them. A case study in Georgia, for example, detailed the treatment of waters severely polluted with human sewage and chicken manure. After flowing through less than 3 miles of wooded swamp, the pollutants were almost entirely filtered out, and following 7 more miles of river swamp "treatment" the water quality was considered excellent.

Those unstudied in water chemistry may question this pollution control capacity, citing the yellowish water that often stands in wetlands, or flows from them. The discoloration is the result of organic acids and biodegrading conditions present in the decaying material of wetlands which promote the solution of iron. This condition is in most cases more aesthetically displeasing than unhealthy, denoting, in fact, a "working" wetland.

The cleansing capacity of wetlands is not limitless. Each wetland is unique and has its own individual capacity. Once this has been exceeded, a wetland can be severely damaged and in some cases "killed". Recovery, if possible at all, is usually never to the original natural state and takes a long time. Further, the long-term cumulative effects of many pollutants, such as heavy metals that tend to collect in peat, are not known. Pollution treatment should be regarded as a natural side-benefit to wetlands, important for water quality improvement within a wetland itself, rather than as a resource for possible development.

Erosion and Sediment Control

Water reaching a wetland, either as surface runoff or through stream channels, often carries a significant amount of silt and organic matter. The quantity of this sediment load is determined by the velocity of the water. Once in a wetland, water spreads and slows, allowing most, if not all, of the carried materials to settle out. Thus, many sediments never reach the channels, rivers and harbors that require expensive dredging to maintain as navigable, or become unwanted fill in ponds, lakes and reservoirs. In addition, the slower flow that leaves a wetland possesses less erosive force, protecting downstream soil resources.

Wetlands also settle or filter out the nutrients often carried in these sediments, a

function important to downstream water bodies. Without such removal, nutrients would accumulate in ponds and lakes, encouraging algae and other plant growth. Where such growth might be a positive factor in a wetland, it degrades open water bodies, filling them with live and decaying vegetation, and robbing them of oxygen vital to fish. This latter process is called eutrophication.

Education and Scientific Research

Wetlands constitute a living classroom, providing first-hand educational and research opportunities for both students and those interested in the biological sciences. Wetlands contain living examples of the food chain, the study of which can begin with microscopic plankton and end with a wetland-related form of life as glorious as the bald eagle. Scientific research on wetland-associated phenomena is helping us to understand natural processes of waste disposal and systems carrying capacity, important questions to our society today. In addition, wetlands provide natural settings for the study of the rare and endangered species plant, bird and animal, that they are often host to. As hardly a town or village lacks such a resource area, this is a valuable educational tool locally available to school and other study groups at no cost.

Other

There is no complete list of wetland functions and benefits, simply because our knowledge about wetlands is still in its infancy. Though not specifically mentioned in the Freshwater Wetlands Act, several others should be noted.

Wetlands host annually harvestable products. These include wildlife, timber, and various aquatic plants. One example of interest is the lowly cattail. Its leaf has a variety of uses. Its fibre has been used as a substitute for jute, cotton and for the manufacture of paper. Its reed hairs can substitute for kapok filler and for insulation. And its root mass has nutrious food value, rich in fats, carbohydrates, protein and minerals, which can be milled into a high-grade flour.

Wetlands also support vast numbers of denitrifying bacteria. These micro-organisms can reduce the load of dissolved nitrogen washed into a wetland, helping to restore the nitrogen balance in nature that so many of Man's activities have upset.

From the perspective of their intrinsic functions, wetlands are a natural wonder of great value to the community. But they are wonders of incredible fragility, dependent on a complex balance of many variables. Man's impact upon wetlands has been destructive because their natural values and that balance have been ignored or forgotten. As we better understand these factors and their complex interrelationship, it is to be hoped that we will protect wetlands as a course of nature, aside from the provisions of the Fresh Water Wetlands Act.

Wetland Destruction

THE IMPACT of past human activities on natural wetlands is almost totally negative. New York State alone has lost more than half of its wetland resources. This destruction has resulted from a prevailing attitude toward wetlands as worthless property. Past activites have centered upon changing wetlands into something else, something "useful" (e.g. dumps, parking lots, building sites, etc.) rather than protecting their natural functions.

As already discussed, the natural functions of wetlands have been until recently ignored or neglected. In clearing and filling a local swamp, people believed they were developing the land and making it "better". These were actions in accord with state policy, which perceived wetlands as a possible health hazard and public nuisance, better "improved" than left in their natural state.

State policy changed with passage of the Freshwater Wetlands Act. That legislation recognized the community value of wetlands in their natural state and for that reason provided for their protection. However, public attitudes are slower to change, creating a negative legacy that impedes effective implementation of the law. To make wetland protection effective, the public must recognize that 1) wetlands have a natural value warranting protection and 2) the destruction of those natural areas has a direct negative impact on the community.

Many wetland activities are obviously destructive. When filled, dumped in, mined, dredged, or dammed, a wetland ceases to exist and its elimination is, in general, permanent. The change effected is irreversible.

Not all activities are so obvious in their impacts, but may be just as destructive in the long run. Specific examples are pollution, alteration of the water level and flow, and urban encroachment.

Pollution

Pollution is taking an increasingly heavy toll. Surface run-off and leaching, industrial wastes, sewage, petroleum products, fertilizers, and pesticides kill wetlands. These pollutants accumulate in wetland vegetation, soils and wildlife, sometimes without notice, until lethal levels are reached. The result is a long-term ecological decline, leaving a poisoned wasteland.

Water Manipulation

Shifting a wetland's water level, up or down, may seem insignificant, but it directly impacts upon wetland vegetation. Small changes can alter the class of a wetland, turning a swamp into a marsh and vice versa (see Glossary "Wetland Classes"), affecting its natural function capabilities. Larger changes, such as flooding or draining, drastically alter a wetland's vegetation, again affecting its class and capabilities.

The causes of change in water level are endless. It can be the result of damming in or near a wetland, or by other alteration of the waterflow that creates a wetland's "wetness". It can also be indirect and seemingly unrelated, as in the blacktopping of an essential aquifer recharge area with a subsurface interconnection with a wetland. In every case, the end result is a change of a wetland's characteristic vegetation, usually representing a lessening of its natural capabilities.

Urban Encroachment

Urban encroachment is an incremental change. It alters the land use of wetlands and of the surrounding open space. Such effects are often seen in wetland areas bordering a waterbody. A cottage is built, then a dock, more cottages, until finally a once natural area is reshaped to human activity. The impact of such development, as tended lawns expand from homesite to homesite, is the gradual elimination of wetlands. Those not filled lose

many of their natural capabilities, overstressed by increased loads of street runoff and eroded soil, sewage leachate, and other pollutants.

Development may also upset a wetland's wildlife balance, even though the wetland itself remains untouched. Distant changes of land use can alter water levels within a wetland, affecting vegetation that determines whether or not the area is suitable as a wildlife habitat. Also, numerous species require a hospitable area surrounding a wetland: in some cases purely as a separation from human activity, in others as an area for foraging or nesting. With the removal or alteration of this natural buffer, the wetland itself becomes uninhabitable.

The regrettable part of past wetland destruction is that much of it has been inadvertent or well-intentioned. A stream channeled for flood control was not meant to dry out a nearby wetland; the paving of a parking area was never intended to waterproof an aquifer important to wetland recharge. Direct or indirect, intentional or by accident, the loss of wetlands is provenly real, and of great cost to the local communities that previously benefitted from their natural functions free of charge.

The Costs of Wetland Destruction

AS PREVIOUSLY DISCUSSED, wetlands provide specific natural benefits. The destruction or degradation of wetlands robs the surrounding local community of these benefits in direct proportion to the wetland's ability to perform its natural functions. Although the extent of such a loss varies from wetland to wetland, there are three potential impacts of major importance to all communities. They are the impacts on water quality, flood control, and wildlife.

Water Quality Degradation

Wetlands are important to the maintenance of water quality. When destroyed, their capacity to filter out and biodegrade pollutants; to reduce sedimentation and turbidity of waters flowing through them; and to augment streams in times of low water or drought is lost.

Their alteration can also affect groundwater supplies in other areas. Although most wetlands act primarily as discharge areas as previously stated, there are conditions wherein they can serve a recharge function. If a wetland has been polluted, or filled for another use, there is then the potential for contamination of underlying aquifers important to local domestic water supply. In this regard, past casual use of wetlands for landfills has placed water quality time-bombs in communities throughout the State.

It should be noted, as well, that water cannot percolate up freely from underground aquifers through a wetland that has been filled. Instead, water is forced into other areas, sometimes affecting soil stability. Settling severe enough to sever utility cables has occurred in the Bronx at Co-op City, a massive residential development built on filled tidal wetlands.

Loss of Flood Control Capacity

The destruction of wetlands, especially from filling or construction, robs a community of natural flood control capacity. Without wetland vegetation, usually the first thing removed in most development, there is nothing to slow the flow of water in times of flood. Gone, too, is the receptive spongelike area where floodwaters can spread and be retained.

In urban areas, this flood abatement function is of significant value as development intensifies runoff. Streets, buildings, and parking lots waterproof the land surface, eliminating soak-in areas and concentrating large volumes of water into sewers and drainage channels. Small storms can thus produce large amounts of runoff quickly, increasing the potential for local and downstream flooding. Wetlands represent an important safety valve at no structural cost, a monetary as well as a natural benefit. (Regretably, they are also often the first areas to receive blacktopping, contributing to, rather than abating the potential for urban flooding).

An unintended consequence of wetland destruction can be costly flood control projects. An example is an U.S. Army Corps of Engineers project on the Esopus Creek in the mid-Hudson city of Kingston. There, a multimillion dollar project was recently completed to protect a shopping center from flooding. The commercial buildings had been built unwisely during the last decade on a filled wetland floodplain and flooded repeatedly. Now, floodwaters are rushed past the levy-protected shopping center and are threatening greater flooding problems downstream. With proper floodplain management, there would have been little or no public expense at the site, and its natural flood control capacity would have been protected to the benefit of all.

Loss of Wildlife

The destruction of wetlands destroys wildlife habitats. Without cover and food, both the population and diversity of species in an area decline. This change impacts both the natural and the human communities. For the natural, or biological community a decrease in species variety creates an instability that will seek a new, but lower level of balance. Reliant upon diversity for strength, the total biological community becomes ever more fragile as species and their population decrease.

Impacts upon the human community are just as real. Where outdoor recreation activities such as hunting and fishing are part of the local economy, fewer fish, birds and animals can cause the loss of important revenue. Lessened, too, are local opportunities for nature study and research by schools and interested individuals. A loss of wildlife also affects the human quality of life, especially in areas where rural land use patterns are giving way to more urban ones. The expense of draining and filling often makes wetlands the last "wild" areas within a developing community. Consciously and unconsciously, people delight in the presence of the diverse animals, birds and plants that wetlands are naturally host to. These natural elements enrich a community and make it a more desirable place in which to live.

Community Impact: an Example

The following hypothetical example illustrates the vital impacts that loss or degradation of wetlands can have on a community.

The place is Marshton, a prospering town located in Upstate New York. Originally a small, isolated farming community, Marshton has grown rapidly in the past decade following completion of a highway that brought it within commuting distance of a large city. The town center, consisting of several blocks of older shops and residences, and a new shopping center, is situated in a valley beside the tree-lived Meander Creek. Recent residential growth has occurred on former pastureland that extends from the valley up onto rolling hills that flank the river.

Marshton was once well supplied with wetlands — in the floodplain area of the Meander Creek, abutting spring-fed Crystal Lake, and in pockets on the hills that rise toward distant mountains. Few of these wetlands are now

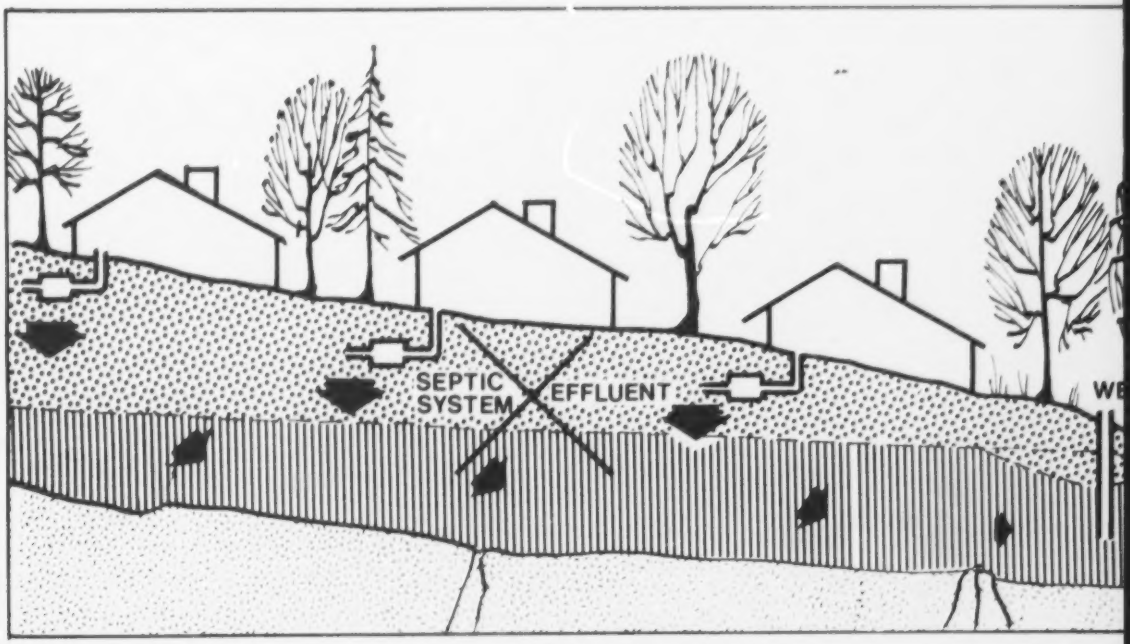
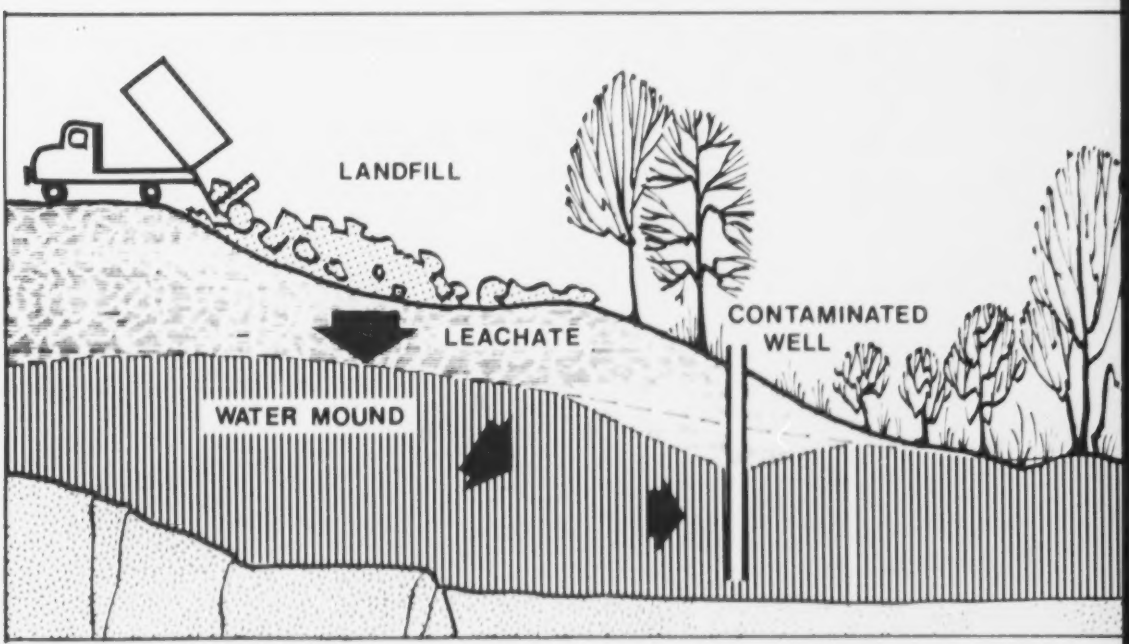


FIGURE 2 Contamination of groundwater from malfunctioning or poorly sited septic systems



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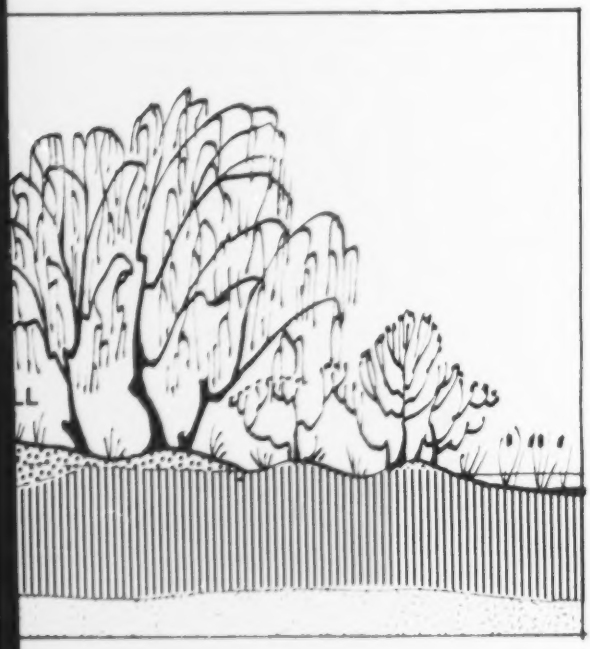
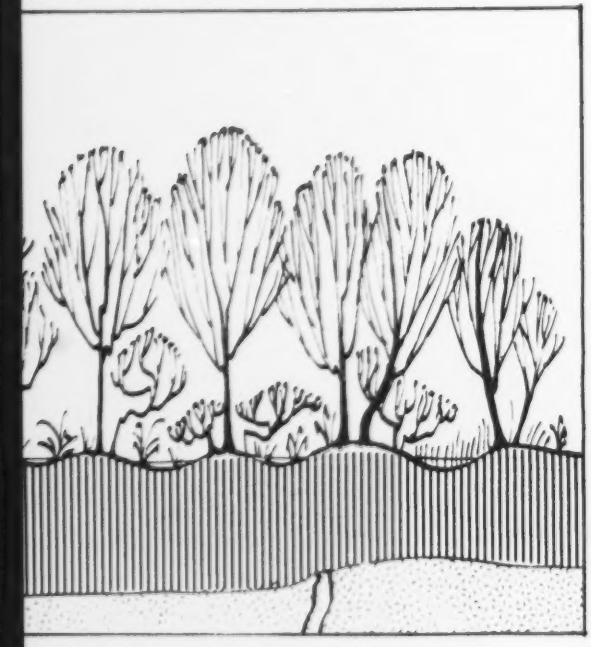


Contamination of groundwater by leachate from landfill



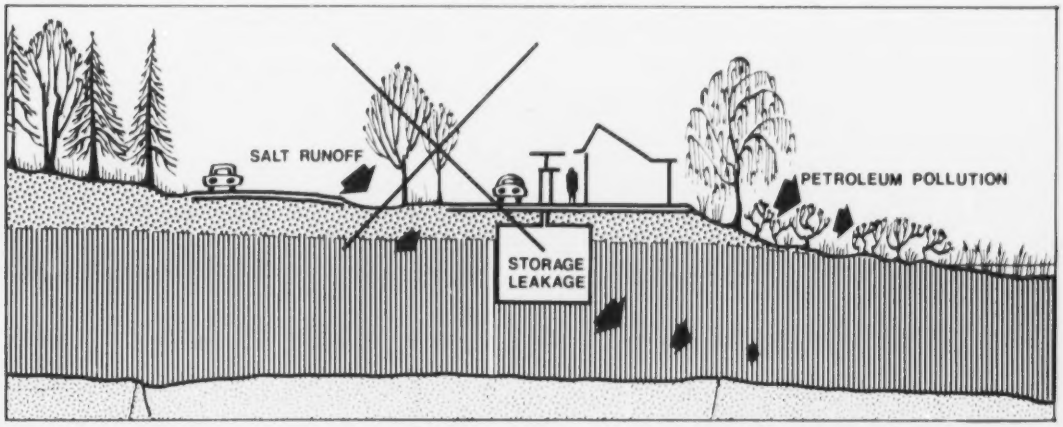
evident, having been drained in the past for farming use and more recently filled to accommodate the new residential development.

A new resident, concerned about the increasingly bad smell to his well water, had the State Health Department test a water sample. The water was found to be close to allowable limits for coliform bacteria. Concerned, he and other residents of the new subdivision petitioned town officials to have the Departments of Health and Environmental Conservation make a complete study to determine the cause of the contamination and the best way to correct the problem.

The pollution's source was soon identified. The old pasture land where the subdivision now stood had orginally been a wet meadow (see Glossary). Septic systems installed with each house had saturated the ground, which was wet by nature, and were affecting the shallow water-supply wells. A groundwater analysis also showed the presence of leachate from a disused town landfill that was located in a marshy area uphill from the new development (Figure 2). To remedy the situation, sewage and water districts were recommended, a costly but necessary step to ensure the health of the new residents.

One problem followed another. People living around Crystal Lake began to notice more and more dead fish that same year; and increasing complaints were being voiced about the algae growth that was expanding across the lake's surface. Tests by the DEC found the lake to contain a wide variety of pollutants. Runoff from the highway, a local gasoline station and a restaurant parking lot were polluting the lake with numerous trace contaminants, including petroleum products, lead, asbestos fibers from brake linings, as well as polychlorinated biphenyls (PCB's) from deteriorating nylon tires. And, wintertime highway deicing was found to have caused a high salt level in the lake. The algae "bloom" was determined to be a result of an overabundance of nutrients leaching into the lake from the many septic systems located in filled wetland areas.

FIGURE 3 Automobile-related pollution of wetland



The lake's water was necessarily reclassified from "A" (drinkable) to "C" (non-contact recreation, e.g. boating). Swimming was no longer allowed and fishing dropped off, especially as the prior bass population of local renown had yielded to more durable but less desirable species. "For Sale" signs soon began to appear in front of many of the lakeside cottages.

The most damaging blow fell when Hurricane Hilda sputtered through the region, dropping six inches of rain in a short period of time on land already saturated by a wet August. The Meander Creek had overflowed before but never with the damage that occurred this year. The new Riverside Acres subdivision was inundated, and the center of town, which had seen flooded lawns on a few past occasions, was left mired in mud a foot or more deep.

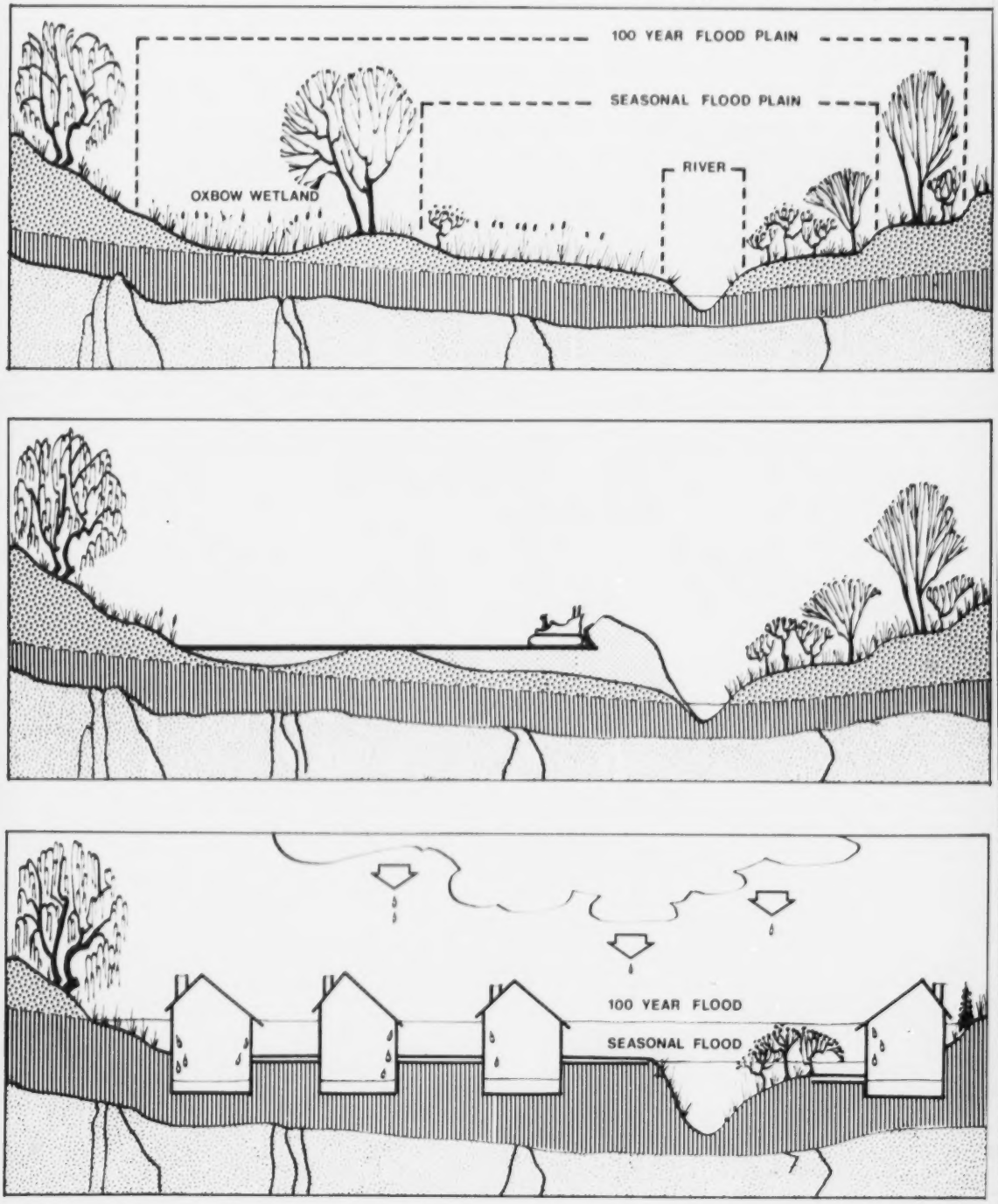
Although past storms had been more severe, the flooding caused by Hurricane Hilda was the worst in 100 years. Graphically illustrated on the opposite page, recent development in the Meander Valley at Marshton had given the creek a new character, with the promise of increased flooding in the future as building in the floodplain is continued.

Damage in the town center was due primarily to the new shopping center. Stores backing onto the creek acted as a dam. Not only had this caused floodwaters to crest higher than ever before, but the new buildings slowed the flow sufficiently for much of the mud and debris to settle out in town, instead of on the lowland fields downstream, as had occurred in the past.

During the clean-up, the decision was made to request federal flood control assistance. Now under study is a proposal to channelize the rampaging Meander Creek. Sadly noted is the planned replacement of the present waterfront park with a concrete retaining wall. Everyone agrees that the center of Marshton will not look quite the same, but at least the flooding problem will be eliminated. No mention is made of the increased potential for downstream flooding created by the project.

The example of Marshton, exaggerated for emphasis, contains only some of the impacts that wetland destruction has had in real communities throughout the State. The message here is not "don't develop". It is rather to illustrate the potential costs to both the community and its individual members that can result from a loss of local wetlands. And, indirectly, it is to underscore the community benefits to be gained by the encouragement of development that complements an area's wetland resources instead of contributing to their destruction.

FIGURE 4 The impact of development in river valley floodplains



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Wetlands and the Law

WETLANDS ARE A DIFFICULT resource to protect. They sprawl across political boundaries; by many, they are considered worthless in their natural state; and their destruction is often the result of seemingly unrelated actions, past and present. For the concerned minority, wetland protection has been a monumental task, a case-by-case fight with limited victories. Passage of the Freshwater Wetlands Act greatly simplified that task by declaring the protection of wetlands to be the public policy of the State of New York.

The Freshwater Wetlands Act of 1975

The Freshwater Wetlands Act provides for the regulation of activities in wetlands in order to protect and preserve the natural benefits to be derived from them. All wetlands greater than 12.4 acres (5 hectares, metric) in size, and smaller ones of unusual local importance are covered by the law. Activities which are regulated include dredging, filling, and discharging potential polutants.

Implementation of wetlands protection under the law is in two phases: an interim permit program under the Department of Environmental Conservation (DEC), during which time a wetlands inventory of the entire State is to be done, and a permanent permit program. The interim program went into effect throughout New York State on September 1, 1975. It will continue in effect in each county until an official wetlands map is filed by the DEC showing the protected wetlands in each county. At that time, the permanent permit program takes effect.

Jurisdiction for the administration of the permanent permit program is the optional responsibility of individual local governing bodies. It becomes a local responsibility only following the adoption of wetlands protection legislation pursuant to the Freshwater Wetlands Act, and proof that the locality can adequately administer it. Where a village, town or city either declines or fails to implement the Act, local jurisdiction can then be assumed by the county government, through legislation enacted within 90 days of the official map-filling date. Again, such legislation must be pursuant to the Act and be adequately administered.

A local government can at a later date assume jurisdiction for administration of the permanent permit program by enacting the prerequisite legislation and providing for its adequate administration. In the absence of such local jurisdiction, or in the case of wetlands of unique environmental value (so designated by the Commissioner following public hearings), the DEC will administer the permanent permit program.

Thus, as of September 1, 1975, any project activity proposed for a wetland protected by virtue of its size or uniqueness is regulated either by the local governmental body or the Department of Environmental Conservation. It should be noted, however, that there are certain exemptions from this regulation granted by the Act itself. These are:

- routine agricultural activities, including draining, do not require permits but do require written notification to the permit authority — filling, however, *is* subject to permit requirements;
- operations necessary for public health; and
- harvesting of natural faunal and floral products of wetlands does not require permits where it is otherwise legally permitted and regulated.

Glossary

THE FOLLOWING SECTION contains more detailed information on the physical characteristics of freshwater wetlands. It is included to assist the interested reader to better understand what wetlands are and why they exist. For those desiring more technical information, readings from the "Selected References" are recommended.

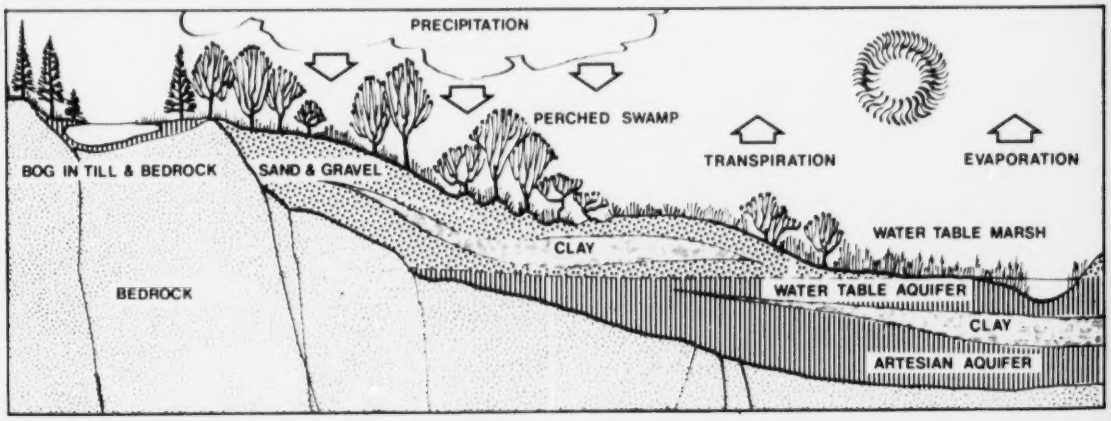


FIGURE 5 The water cycle

The Water Cycle

Part of understanding wetland characteristics is understanding the water cycle. All water, whether in the air, on the land, in the sea, or beneath the earth's surface, is in constant circulation. The basic flow is from the oceans to the atmosphere to the land and back to the oceans.

The cycle is powered by solar energy. The sun and wind evaporate water from the surface of open water bodies. Additional amounts of water are released to the atmosphere by plants and trees through their leaves, a process called transpiration. Together, these two sources are referred to as **evapotranspiration.** The warm water vapor at the earth's surface rises into the cooler upper atmosphere, condenses, and falls back to the earth's surface as rain, sleet and snow.

Some of this precipitation falls directly on surface water bodies. Another portion falls on land, where it either runs off into surface water bodies or soaks slowly into the ground. The surface water flows downhill, joining creeks, streams and rivers and, eventually, flows to the sea. Even water temporarily stored along the way, in ponds and lakes, subsequently drains to the sea.

Water infiltrating the soil, termed "groundwater", is drawn downward by gravity and capillary action. A small amount is retained near the surface as soil moisture. Here, the soil itself is not saturated; air spaces remain, and the area is known as the **zone of aeration.**

Water continues its downward movement until it fills these spaces, and those between sand and gravel, and fractures in the bedrock. This is the **zone of saturation,** the top of which is commonly known as the **water table.** Once below this level, water is free to move laterally depending on geologic conditions, although it will always tend downward. The soil and rock layers through which water flows are known as **aquifers,** which act as natural subsurface water conduits.

Aquifers, which in many cases provide important water supply to wetlands, are generally of two types: water table and artesian. A water table aquifer is unconfined — that is, there is no impervious layer above it. An artesian aquifer is confined by impervious layers. Due to the resupply that continually enters it, its water is under pressure, much as

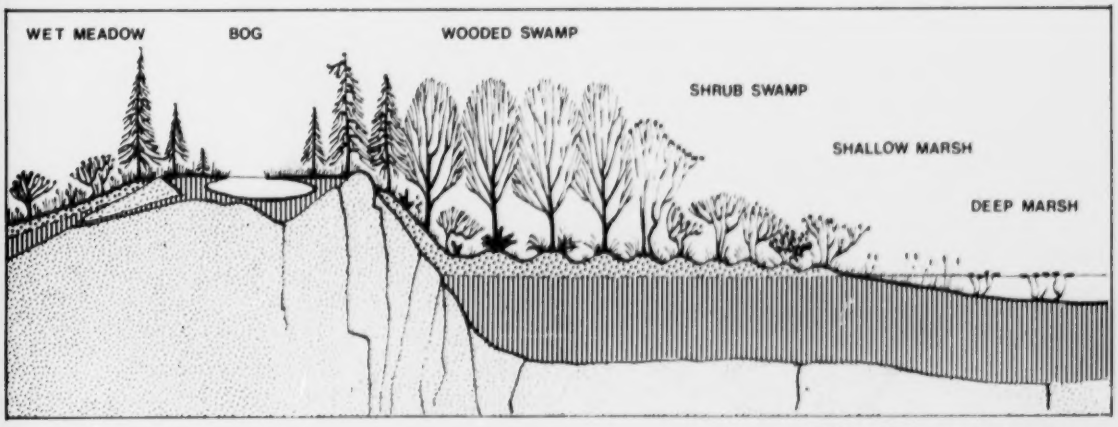


FIGURE 6 Wetland classes

water would be in a pipe connected to a reservoir. Pierced by a well, water will flow up from the artesian aquifer. The water level in a water table well will rise only as high as the water table itself.

Referring to Figure 5, groundwater filters downward until it meets an impervious layer, one that does not transmit water or does so only slowly. At the top of the hill the bedrock is impervious, holding the ground water as if in a bowl. Soil and other conditions have facilitated the formation of a bog. Clay is another material that impedes water flow. Either water finds a way around a clay layer to continue downward, or it will saturate the soil locally, creating in this example a perched swamp.

The water cycle is seen to be a dynamic system of water flow above and below the Earth's surface. The way in which that flow occurs beneath the ground determines many types of wetlands, aquifer discharge serving to keep the area wet. Equally important, wetlands are seen to be directly interconnected with the groundwater system. Thus changes to one can intimately affect the other.

Wetlands — General Definition

Defined simply, wetlands are those areas of land where the presence of water determines the nature of the site and its vegetation. Ranging from wet to almost dry, wetlands may have open water with aquatic plants growing beneath and on the surface, or have mature forests that are frequently flooded and dotted with spring-fed pools.

Wetland Classes

For New York State and the Northeast, the common wetland categories are wet meadows, shallow wet marshes, deep wet marshes, shrub swamps, wooded swamps, bogs, open water and seasonally flooded flats. Of these, shrub and wooded swamps make up about half of the state's wetlands, with marshes constituting another third of the remaining total.

BOTH MARSHES and SWAMPS occur in wide depressions where there is little water movement and where marsh grasses, reeds, or

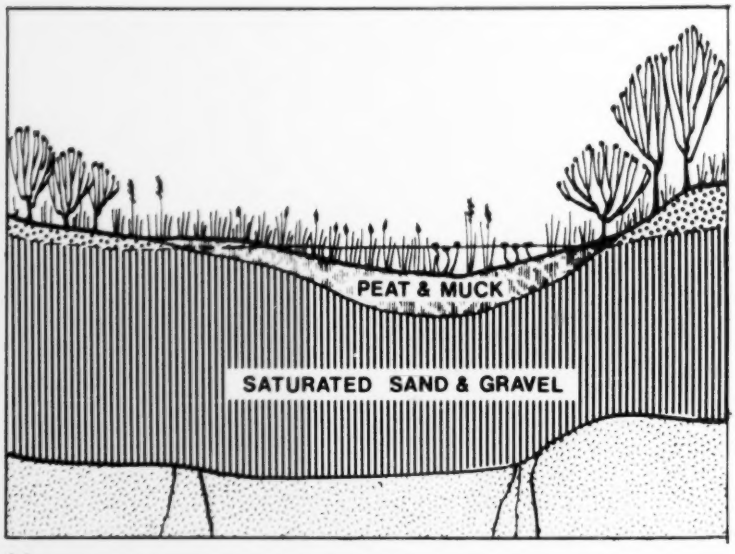
water-tolerant shrubs and trees can take hold. During the growing season, water levels average between 6 inches and 3 feet for deep fresh marshes, and less than 6 inches for shallow fresh marshes. As decaying material accumulates, deep marshes fill in to become shallow marshes. If shrubs such as alder and buttonbush take over, the marshes become shrub swamps. Finally, if trees such as red maple, elm, and ash take root, the shrub swamp becomes a wooded swamp. This natural progression from one type of plant growth to another is called **succession.**

WET MEADOWS are areas where groundwater is present at shallow depths, keeping the soils saturated to the surface throughout the growing season. Commonly, this water seeps out along hillsides. During the late fall, winter and early spring there can be as much as 6 inches of surface water present. This wet condition allows for emergent plant growth (see Glossary — "Wetland Characteristics") typified by purple loosestrife found also in marshes and swamps.

BOGS are wetlands found in poorly drained areas with acid conditions that promote the growth of sphagnum moss and a distinctive flora including unique insect-eating plants. As the moss dies, it tends to accumulate as peat, rather than decay to muck, and thereby determines the nature of the general plant community.

OPEN WATER applies to water 3 to 10 feet deep associated with any of the wetland categories, but usually with deep or shallow marshes. Its inclusion as a wetland type is due to the particular vegetation growing on or beneath the surface, referred to as submergent and floating attached vegetation (see Glossary "Wetland Characteristics").

SEASONALLY FLOODED FLATS, also referred to as streamside or linear wetlands, are extensive river floodplains where flooding to a depth of 12 inches or more may occur annually during the late fall, winter and spring. During the summer, the soil is saturated, with a few inches of surface water occurring in isolated spots. The dominant vegetation is emergent, but shrubs and scattered trees may be present.



Water table wetland

Wetland Geology

Wetlands are formed where the local water table intersects or occurs within a few inches of the earth's surface during most of the year. Their existence and characteristics are closely related to the distribution and types of soil and rock immediately beneath the surface. To illustrate this relation, the conditions creating four general types of wetlands are diagrammed in cross-section (Figures 7, 8, 9, 10).

A WATER TABLE WETLAND is situated on sand and gravel deposits where the water table intersects or occurs slightly below permeable, or water transmittable, sand and gravel beds. A water table wetland is also a function of the organic layer of peat and muck that accumulates on the bottom. This material tends to transmit water more slowly than the deposits on which it rests, helping to keep water entering the wetland from seeping down too quickly. Due to its direct connection with a water table aquifer supply, this type of wetland tends to be permanent, that is it keeps its wetland character independent of changes in weather or stream flow.

A LAKE BOTTOM WETLAND is situated on layers of poorly permeable clay interbedded with permeable sand and gravel. The confining layers create an artesian supply, a constant flow of water that tends to make this the most permanent wetland type of all. With its active aquifer discharge, a lake bottom wetland is little affected by short-term climate or stream-flow changes. Under pressure, the artesian supply constantly percolates through the clay and silt to form a shallow perched water layer on top of the clay. Such a wetland may present surface evidence for major water supplies, the extent of which can be determined through hydrologic and geologic studies.

A PERCHED WETLAND is one lacking an active groundwater supply, its "wetness" being dependent upon precipitation or periodic flooding. It exits where water is trapped at the surface by underlaying impervious layers, unable to infiltrate downward or flow sideward. Such confining layers can be bedrock lacking sufficient fractures to transmit water, or sedimentary beds of clay or other poorly permeable material. Due to its reliance

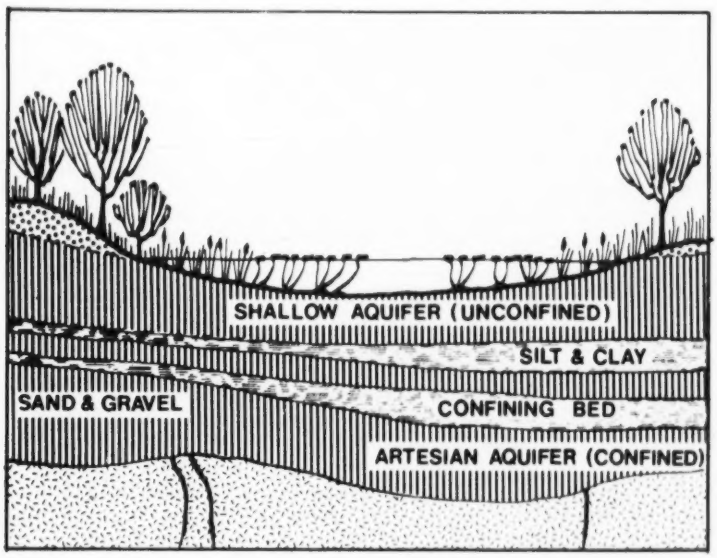


FIGURE 8
Lake bottom wetland

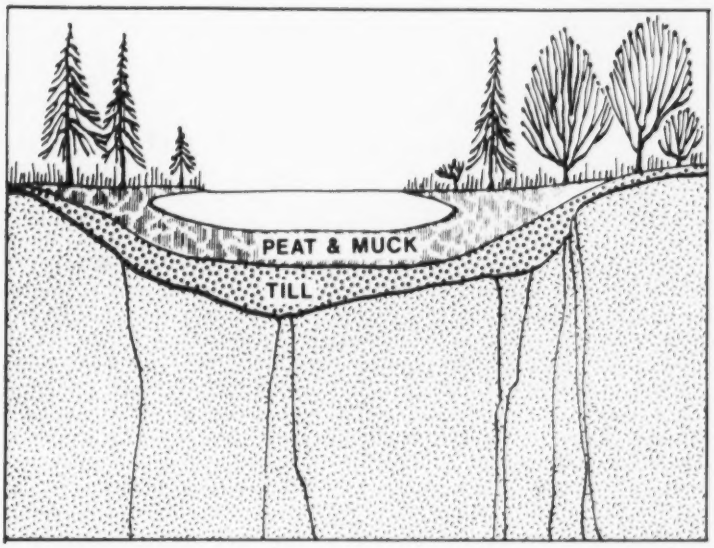


FIGURE 9
Perched wetland over bedrock

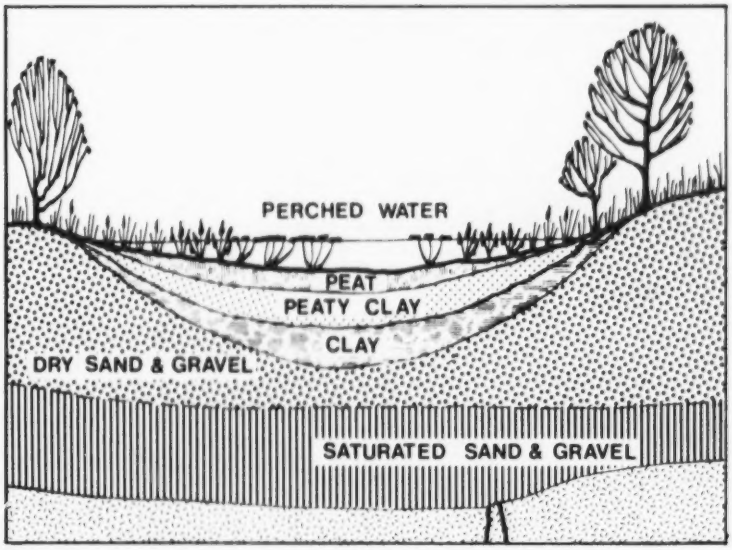


FIGURE 10
Perched wetland over clay

on surface water supply, this tends to be the least permanent type of wetland, being wet or dry depending upon the weather or the season.

Wetland Characteristics

Although previous descriptions are informative, it is important to realize that the identification of wetlands by geologic formations would require expert and expensive study. More available and easier to identify are their obvious surface characteristics. These are features that define wetlands for the layman and reveal information about a wetland's important natural functions.

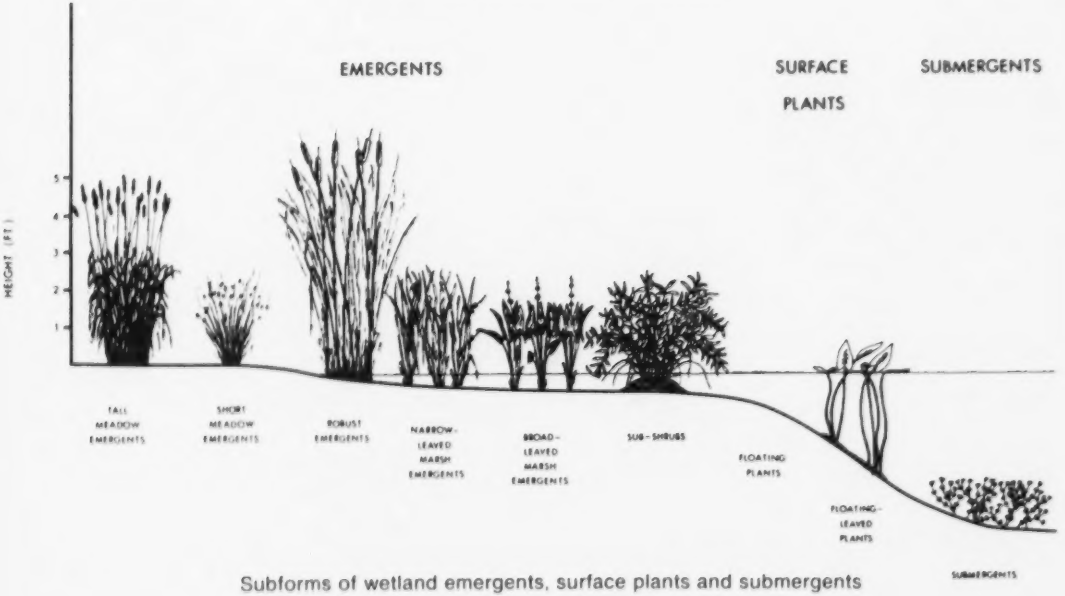
VEGETATION

Each wetland class has a particular regime of water levels, flow, and permanence associated with it. These, in turn, determine the types of vegetation that can take hold and maintain themselves. For this reason, vegetation is a primary wetland identifier, more so than the degree of wetness which may vary from season to season. It is also the criterion established by the Freshwater Wetlands Act as the legal basis for determining whether or not an area is a wetland.

Under the Act, freshwater wetlands are defined as lands and submerged lands com-

FIGURE 11

Subforms of wetland trees and shrubs



Subforms of wetland emergents, surface plants and submergents

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monly called marshes, swamps, sloughs, bogs, and flat supporting aquatic or semi-aquatic vegetation of the following types:

(1) wetland trees, which depend upon seasonal or permanent flooding or sufficiently water-logged soils to give them a competitive advantage over other trees; including, among others, red maple *(Acer rubrum)*, willows *(Salix spp.)*, black spruce *(Picea mariana)*; swamp white oak *(Quercus bicolor)*, red ash *(Fraxinus pennsylvanica)*, black ash *(Fraxinus nigra)*, silver maple *(Acer saccharinum)*, American elm *(Ulmus americana)*, and Larch *(Larix laricina)*;

(2) wetland shrubs, which depend upon seasonal or permanent flooding or sufficiently water-logged soils to give them a competitive advantage over other shrubs; including, among others, alder *(Alnus spp.)*, buttonbush *(Cephalanthus occidentalis)*, bog rosemary *(Andromeda glaucophylla)*, dogwoods *(Cornus spp.)*, and leatherleaf *(Chamaedaphne calyculata)*;

(3) emergent vegetation, including, among others, cattails *(Typha spp.)*, pickerelweed *(Pontederia cordata)*, bulrushes *(Scirpus spp.)*, arrow arum *(Peltandra virginica)*, arrowheads *(Sagittaria spp.)*, reed *(Phragmites communis)*, wildrice *(Zizania aquatica)*, bur-reeds *(Sparganium spp.)*, purple loosestrife *(Lythrum salicaria)*, swamp loosestrife *(Decodon verticillatus)*, and water plantain *(Alisma plantago-aquatica)*;

(4) rooted, floating-leaved vegetation; including, among others, water-lily *(Nymphaea odorata)*, water shield *(Brasenia schreberi)*, and spatterdock *(Nuphar spp.)*;

(5) free-floating vegetation; including, among others, duckweed *(Lemna spp.)*, big duckweed *(Spirodela polyrhiza)*, and watermeal *(Wolffia spp.)*;

(6) wet meadow vegetation, which depends upon seasonal or permanent flooding or sufficiently water-logged soils to give it a competitive advantage over other open land vegetation; including, among others, sedges *(Carex spp.)*, rushes *(Juncus spp.)*, cattails *(Typha spp.)*, rice-cut-grass *(Leersia oryzoides)*, reed canary grass *(Phalaris arundinacea)*, swamp loosestrife *(Decodon verticillatus)*, and spikerush *(Eleocharis spp.)*;

(7) bog mat vegetation; including, among others, sphagnum mosses *(Sphagnum spp.)*, bog rosemary *(Andromeda glaucophylla)*, leatheleaf *(Chamaedaphne calyculata)*, pitcher plant *(Sarracenia purpurea)*, and cranberries *(Vaccinium macrocarpon and V. oxycoccos)*;

(8) submergent vegetation; including, among others, pondweeds *(Potamogeton spp.)*, naiads *(Najas spp.)*, bladderworts *(Utricularia spp.)*, wild celery *(Vallisneria americana)*, coontail *(Ceratophyllum demersum)*, water milfoils *(Myriophyllum spp.)*, muskgrass *(Chara spp.)*, stonewort *(Nitella spp.)*, water weeds *(Elodea spp.)*, and water smartweed *(Polygonum amphibium)*.

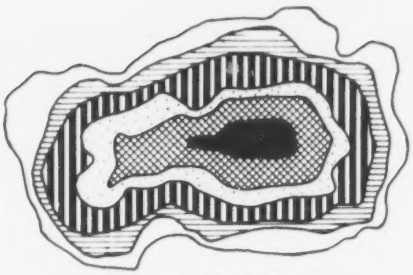
SIZE

Wetlands in the glaciated Northeast can range in size from less than one acre to several thousand acres. Large complexes are often formed by the juxtaposition and interconnection of small to medium sized wetlands. In general, large wetlands (greater than 100 acres) are longer lived than smaller ones due to their usual association with a permanent water table and an extensive watershed. However, the importance or value of a wetland is not determined by its size, but by its location, function and uniqueness.

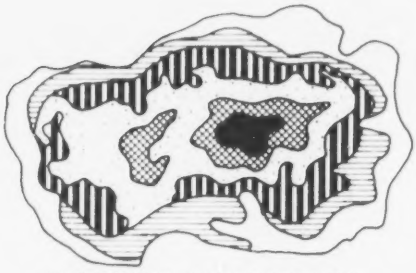
SITE TYPES

"Site type" is a descriptive term based upon topographic and hydrologic location. Topographic location can be broadly categorized as either upland or bottomland. **Upland** sites lie above alluvial or outwash plains (the sedimentary remains of rivers) and above stream valleys and floodplains. Most upland wetlands are perched, occurring on bedrock, till or small pockets of outwash overlying till. **Bottomland** sites lie on the alluvium of

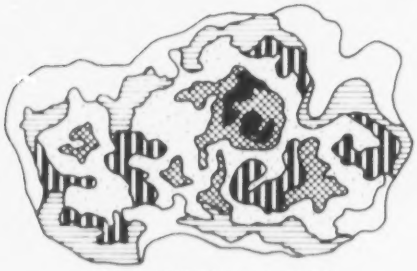
FIGURE 12



LOW INTERSPERSION



MODERATE INTERSPERSION



HIGH INTERSPERSION

stream floodplains, on outwash plains or on glacial lake deposits. A perched condition may occur, but underground water supplies are the rule.

A wetland's hydrologic location may be **isolated, streamside, lakeside** or **deltaic.** To be **isolated,** the wetland must not border any larger body of open water. Small streams may course through it, but the wetland is not subordinate to the streams. Isolated wetlands usually owe their wetness as much to groundwater seepage and surface run-off as to streamflow. **Streamside** wetlands occur along a large stream and occupy part or all of its floodplain. A **lakeside** wetland occurs on the margin of a lake. A **deltaic** wetland lies at the point where a stream enters a lake.

ASSOCIATION OF VEGETATIVE COVER AND OPEN WATER

A wetland can be characterized by its proportion of vegetative cover to open water, and the degree to which the two are intermixed. These factors are particularly important to the wildlife value of a wetland. The edge formed where vegetation and water meet establishes a variety of habitats and separates one from another. This edge is also a productive food area for wildlife.

VEGETATIVE INTERSPERSION

The separation between types of vegetation in wetlands is not usually sharp, one type thinning to intermix with another before giving way entirely. There is, however, a general separation of vegetative types establishing another "edge". Both the length of edge and its variety are important determinants for wildlife species population and diversity within a wetland (Figure 12).

In a wetland with **high interspersion**, there is a complicated mix of vegetative types. The edge is abundant, with many kinds of shapes and heights. Vegetation is broken into many units rather than growing in continuous stands. With **moderate interspersion**, there is some variety in the distribution of stands of vegetation, but the stands themselves are largely

unbroken. With **low interspersion**, a wetland consists of concentric stands that are large and unbroken. Edge in moderate and low interspersion wetlands becomes shorter and less diverse, limiting the availability of food and habitat for wildlife.

These are the major characteristics associated with wetlands in New York and the Northeast. Other measurable components, e.g. water chemistry, may have significance to individual wetlands or to more formal research, but they are less important to a broad study.

Each characteristic is part of an intricately balanced whole. The variation or modification of any wetland component — water level, vegetation, surrounding land use — affects the wetland as a whole. Such changes invariably degrade the natural functions performed by wetlands.

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*Denotes primary reference material, for which acknowledgment is given in the Preface.